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EFFECTS OF MANNAN OLIGOSACCHARIDES AS A DIETARY SUPPLEMENT ON PERFORMANCE AND CARCASS CHARACTERISTICS OF JAPANESE QUAILS (COTURNIX JAPONICA)

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ABSTRACT

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The effect of three levels of mannan oligosaccharides (MOS) as a dietary supplement on growth performance, carcass characteristics and some blood metabolites of growing Japanese quails (*Coturnix japonica*) was the main objective of this experiment. A total of one hundred 1-day-old Japanese quails were randomly divided into 4 experimental groups (25 birds/ each treatment) with 3 replicates (8 birds in two replicates and 9 birds in one replicate). The experimental groups consisted of four dietary treatments: 1) a control basal diet without supplementation; 2) a basal diet with a MOS at level of 1 g/kg feed (low MOS); 3) a diet with MOS at a level of 3 g/kg feed (medium MOS); and 4) a diet with a MOS at a level of 5 g/kg feed (high MOS). The experimental period extended for 42 days. The data revealed that, birds fed diets containing medium MOS level (3 g /kg feed) recorded significant ($P < 0.05$) improvements in body weight, weight gain, feed conversion efficiency, performance index, energy and protein efficiency compared with those fed the control one, low and high levels of MOS. Also medium level of MOS supplementation increased the dressing percentage and edible giblets, while the offal's percentages and carcass abdominal fat were significantly decreased. Growth performance was significantly improved at 3 g MOS/ kg diet, however high dosage of MOS have negative effects on growth rate of the birds. The triglyceride, total cholesterol and total lipids concentrations in quails blood decreased significantly in concomitant with a significant decrease in carcass fat % as a response to dietary MOS supplementation. From the results of the current study, it could be concluded that the responses of Japanese quails to MOS are influenced by the level of its supplementation in the diet. Therefore, this factor needs to be carefully considered in order to obtain maximal growth-promoting effects of MOS in Japanese quail production.

Key words: *Mannan oligosaccharides, growth performance, carcass characteristics, blood metabolites, Japanese quails*

INTRODUCTION

Currently, many parts of the world are experimenting alternative feed additives that may be used to alleviate the problems associated with the withdrawal of antibiotics from feed. Alternatives to antibiotics including enzymes, organic acids, probiotics, prebiotics, herbs and etheric oils, immuno-stimulants and other management practices. These alternatives promote gut health by several possible mechanisms including altering gut pH, maintaining protective gut mucins, selecting for beneficial intestinal organisms or against pathogens, enhancing fermentation acids, enhancing nutrient uptake, and increasing the humoral immune response (Inborr, 2000). One of these alternatives is prebiotics. Gibson and Roberfroid (1995) defined a prebiotic as a non-digestible food ingredient which beneficially affects the host by selectively stimulating the growth and/or activating the metabolism of one or a limited number of health-promoting bacteria in the intestinal tract, thus improving the host's microbial balance. The growth of endogenous microbial population groups such as *bifidobacteria* and *lactobacilli* is specifically stimulated and these bacteria species are perceived as beneficial to animal health (Yang *et al.*, 2007).

Prebiotics are polysaccharides and oligosaccharides which cannot be digested effectively by the animal, but are readily fermented by anaerobic, colonic bacteria that are regarded as beneficial ones (Zhang *et al.*, 2003). Prebiotics have shown promise in controlling pathogens such as *Salmonella* and *Escherichia coli* and in stimulating the growth of *bifidobacteria* and *lactobacilli*, thus promoting health and performance of animals (Xu *et al.*, 2003; Zhang *et al.*, 2003; Chung and Day, 2004; Yang *et al.*, 2007). Some researchers hinted that prebiotics may have cholesterol-lowering properties (Liong and Shah, 2006; Li *et al.*, 2007). Some positive changes in digestive enzymes, gut morphology, and immune system were noticed in birds given prebiotic-supplemented feed (Xu *et al.*, 2003; Zhang *et al.*, 2003; Huang *et al.*, 2007). However, there are many considerations in supplementing prebiotics in animal feed. These include type of the diet (i.e., the content of non-digestible oligosaccharides) and the inclusion level of the supplements; animal characteristics (species, age, stage of production); and the hygiene status of the farm (Verdonk *et al.*, 2005).

Japanese quail (*Coturnix japonica*) is a diversified poultry species reared for commercial egg and meat production. It is blessed with unique characteristics of fast growth, early sexual maturity, high rate of egg production, short generation interval and shorter incubation period that makes it suitable for diversified animal agriculture. The information about the effective level of MOS that optimizing growth and maximize production is lacking.

Therefore, the objective of the present study was to investigate the effect of different dietary levels of mannan oligosaccharides (MOS) on growth performance, carcass characteristics and on some blood metabolites of the growing Japanese quail (*Coturnix japonica*).

MATERIALS and METHODS

Bird and housing:

This study was carried out at the quail production unit, Faculty of Veterinary Medicine, South Valley University, Egypt, during the period from May to June 2011. Chemical analyses were performed in the laboratories of the Department of Nutrition and Clinical Nutrition, Faculty of Veterinary Medicine, Assiut University, Assiut, Egypt. A total number of 100 one day old Japanese quail chicks were divided randomly into four treatments (25 birds each); each group was subdivided into three replicates (two of 8 birds and one of 9 birds /battery cage).

Chicks were individually weighed to the nearest gram at the start of experiment (the mean of the initial body weight was about 9.66 ± 0.26 g), wing-banded and randomly allotted to the dietary treatments. Chicks were raised in electrically heated batteries with raised wire mesh floors and had a free access to the mesh feed and fresh water from nipple drinkers throughout the experiment. Light was provided for 23 h/d. Room temperature on day 0 was 35°C and decreased approximately 2.5°C per week until 25 °C was reached, according to standard poultry rearing practices. Batteries were placed into a room provided with continuous fans for ventilation. Heating and forced ventilation system allowed room temperature to be maintained between 25 and 35 °C.

Dietary treatments:

The dietary treatments were: 1(a control diet without Y-MOS supplementation; 2) a diet with a prebiotic Y-MOS at a level of 1 g/kg feed; 3(a diet with Y-MOS at a level of 3 g/kg feed, and 4) a diet with a Y-MOS at a level of 5 g/kg feed. Diets were fed in mash form. A commercial prebiotic source Y-Mos® (Nutrex, Belgium) was used in this experiment, chemical composition of the Y-MOS is presented in Table 1.Basal diet was formulated to contain the ME density (2900 kcal/kg) and crude protein (24 %) concentrations recommended by NRC (1994). Physical and calculated chemical compositions of the basal experimental diet are presented in Table 2. No coccidiostats or antibiotics were used during the study. Feed and water were provided *ad libitum*. All birds were kept under hygienic conditions and were subjected to a prophylactic vaccination against viral diseases.

Growth Performance and feed conversion:

All birds were weighed individually (initial weight) and every week during the course of the experiment. Feed consumption was recorded weekly in the course of the whole experiment per pen basis, and calculated at days 21 and 42 of the experiment and the feed conversion rates were calculated subsequently. Feed conversion ratio was calculated as the amount of feed consumed per unit body weight gain and was adjusted to the weight of chicks at the first day. Performance Index for each group was calculated by dividing the total weight gain (g) by the feed conversion ratio (Ghosh *et al.*, 2007). Mortality was recorded as it occurred.

Carcass traits:

Five birds randomly selected from each group were slaughtered at the end of the experiment. The birds were fasted for 10-12 h prior to determination of the final body weight at slaughtering, carcass weight (the weight of the slaughtered birds after removal of feathers, head, and feet but including the edible giblet (liver without gall bladder, heart, skinned empty gizzard and abdominal fat). The absolute organ weights were recorded. Dressing %, offal's %, and giblet % are calculated as relative weight to live body weight.

Meat chemical composition:

Different parts from the carcass as breast and thigh were sealed in polyethylene bags and frozen at -20 °C for further analysis. The meat was removed from the bones, it was homogenized and it was analyzed for crude protein, crude fat, moisture and ash, according to the guidelines of AOAC (2005).

Blood Collection and Analysis:

At the end of the experimental period (day 42), 5 birds were randomly selected from each group and blood samples were collected from the bronchial vein during slaughter. The collected blood samples were centrifuged at 4000 rpm for 15 min and the sera were decanted into aseptically treated vials and stored at – 20 °C until further analysis. Serum samples were analyzed for total protein, albumen, glucose, total cholesterol, total lipid and triglycerides, by spectrophotometer using commercial test kits (Spectrum, Cairo, Egypt).

Statistical analysis:

The data were subjected to statistical analysis with one way AOVA using SPSS program for Windows Version 13; (SPSS GmbH, Munich, Germany) to determine if variables differed between groups. Statistical significant effects were further analyzed, and means were compared using Duncan's multiple range test. Statistical significance was determined at $P (< 0.05)$.

RESULTS

Growth Performance:

The effects of MOS supplementation on BWG, FI and FCR, performance index of the quail are presented in Table 3. Growth performance of the Japanese quail was affected by dietary addition of MOS. As shown in Table 3, there were no significant differences ($P > 0.05$) in the initial BW of chicks between the dietary treatments. The average feed intake was not significantly differed ($p > 0.05$) among treatments at the first 3 weeks. Medium MOS group showed the highest body weight gain (g) and performance index (98.25, 53.43) followed by low MOS group (94.8, 43.04), control (92.24, 44.56) and high MOS group (84.9, 37.21), respectively in the first 3 weeks. At the same time (4-6 weeks) quails fed diet supplemented with medium MOS had significant increases in body weight gain, performance index beside improving feed conversion rate in comparison with the other dietary groups. Also, the feed conversion was significantly ($p < 0.05$) improved in medium MOS supplemented group at the last 3 weeks compared to those of the low and high ones. At the last 3 weeks the feed intake was significantly higher ($p < 0.05$) for birds fed the diet supplemented with high MOS. The cumulative feed consumption per quail during the whole experimental period (0-6 weeks) was significantly higher in both low and high MOS supplemented birds in comparison with the control group, however medium MOS supplemented group showed an intermediate values. Quails fed diet supplemented with medium MOS had significant increases in the cumulative (from 0 to 6 week) body weight gain, performance index and improved feed conversion rate compared to the other dietary groups. Mortality % was relatively low numerically for birds supplemented with MOS in comparison with control group and it was ranged from 8 % to 12 %. Generally, Medium MOS had improved quails performance and feed conversion efficiency.

Energy and protein efficiency:

Energy and protein efficiency of growing quails fed the experimental diets are exhibited in Table 4. The results showed that energy efficiency (ME intake, kcal/g weight gain) and protein efficiency (protein intake, g/g weight gain) were significantly ($p<0.05$) improved in medium MOS supplemented group compared to low and high MOS supplemented groups, a matter which mean that birds fed low and high MOS levels consumed more energy and protein per unit gain than those fed on medium MOS level.

Carcass traits, absolute organ weights and meat chemical composition:

MOS supplementation significantly altered ($p<0.05$) carcass characteristics of growing Japanese quails. The data in Table 5 indicated that, carcass weight, and dressing % of medium MOS supplemented quails were significantly ($p<0.05$) higher than those supplemented with low and high MOS levels. Moreover, carcass of medium MOS supplemented quails had lower offal's weight and lower abdominal fat than other groups. In addition, the absolute liver and gizzard weight were significantly higher in medium MOS supplemented quails. Table 6 revealed that, the meat chemical composition of quails fed diet supplemented with medium MOS had a lower fat and ash %.

Blood metabolites:

The mean serum concentrations of the total protein and glucose increased significantly in all MOS supplemented birds and being highest in low MOS level supplemented group (Table 7). Serum total cholesterol, total lipids and triglyceride significantly decreased ($p<0.05$) in MOS supplemented groups.

Table 1: Chemical composition (%) of mannan oligosaccharide product (Y-MOS).

Ingredients	Y-MOS
DM	95
Protein /DM%	25
Ash	6
Polysaccharides	
B-Glucanes	28
Mannan oligosaccharides (MOS)	28

Table 2: Physical and calculated chemical composition of basal diet fed for Japanese quails (%, as fed-basis)

Ingredients	%
Yellow corn	55.95
Soybean meal (48)	39.6
Sunflower oil	1.00
Dicalcium phosphate	1
Ground limestone	1.5
Iodized salt	0.4
Premix*	0.25
L-lysine	0.1
DL-methionine	0.2
Total	100
Calculated composition	
Energy ME kcal /Kg	2937.16
CP (%)	24.04
EE (%)	2.36
CF (%)	3.22
Ca (%)	0.91
Av. P (%)	0.31
Lysine (%)	1.41
Meth.+Cys. (%)	0.75

*Mineral and vitamin premix, Heromix broilers (Heropharma Co., Egypt)
Each 2.5 kg contain: 12,000000 IU Vit. A, 2,000000 Vit D3, 10 g vit. E, 2g Vit K3, 1g Vit. B1, 5g vit B2, 1.5 g Vit. B6, 10 mg Vit B12, 30 g nicotinic acid, 10 g pantothenic acid, 1g folic acid, 50 g biotin, 250 g choline chloride 50 %, 30g iron, 10 g copper, 50g zinc, 60 g manganese, 1g iodine, 0.1 g selenium, 0.1 g cobalt and carrier $Caco_3$ to 2.5 kg

Table 3: Body weight gain (BWG), feed intake (FI), feed conversion efficiency (FC), performance index and mortality of different experimental groups

Items	Control	Low MOS	Medium MOS	High MOS	P
0-21 d ay					
Initial BW (day1)	9.68±0.22	9.76±0.29	9.51±0.25	9.71±0.32	0.92
Live BW (day 21)	101.92±0.52^{c}	104.56±0.91^{b}	107.76±0.55^{a}	94.6±0.99^{d}	000
FI (g/bird)	190.95±1.85	209.33±7.31	198.2±2.6	193.87±4.7	0.08
BW gain (g/bird)	92.24±0.59^{c}	94.8±0.97^{b}	98.25±0.57^{a}	84.9±0.98^{d}	0.000
FC (g/g)	2.07±.02^{abc}	2.2±0.01^{cd}	2.01±0.03^{b}	2.28±0.05^{d}	0.02
Performance Index*	44.56±0.43^{c}	43.04±1.5^{c}	48.72±0.65^{a}	37.21±0.78^{b}	0.000
22-44 day					
FI (g/bird)	396.66±8.8^{d}	426.00±3.1^{cd}	410.0±2.9^{abc}	430.0±5.8^{a}	0.01
BW gain (g/bird)	88.56±1.2^{d}	97.68±1.4^{b}	110.16±1.7^{a}	89.4±1.5^{c}	0.000
FC (g/g)	4.48±0.09^{b}	4.36±0.03^{c}	3.72±0.02^{d}	4.8±0.06^{a}	0.000
Performance Index	19.79±0.44^{c}	22.39±0.16^{b}	29.6±0.21^{a}	18.59±0.24^{d}	0.000
0-42 day					
B W (final)	190.48±1.2^{c}	202.74±1.5^{b}	217.92±1.7^{a}	184.00±1.4^{d}	0.000
FI (g/bird)	587.62±7.54^{c}	635.33±2.4^{a}	608.2±5.3^{ab}	623.87±8.6^{b}	0.01
BW gain (g/bird)	180.8±1.2^{c}	192.5±1.6^{b}	208.41±1.7^{a}	174.29±1.5^{d}	0.000
FC (g/g)	3.25±0.04^{c}	3.3±0.05^{b}	2.91±0.03^{d}	3.57±0.05^{a}	0.000
Performance Index	55.64±0.75^{c}	58.35±.95^{b}	71.42±0.62^{a}	48.71±0.66^{d}	0.000
Mortality, %	20	8	8	12	

Figures in the same raw with different superscript differ significantly ($p < 0.05$).
Values are reported as means ± SE.
Low MOS (1 g MOS /kg feed); medium (MOS 3 g MOS /kg feed) and high MOS (5 g MOS /kg feed) treatments in the first 3 weeks and last 3 weeks, respectively
FI=Feed intake FC= Feed conversion FC= feed intake (g)/weight gain (g)
*Performance Index= weight gain (g)/ FC ratio

Table 4: Energy and Protein efficiency of growing Japanese quails fed the experimental diets

Items	Control	Low MOS	Medium MOS	High MOS	P
ME intake kcal/bird					
0-21day	560.87±5.44	614.84±21.47	582.17±7.65	569.44±11.97	0.08
22-42 day	1165.07±25.9^{bc}	1251.23±8.97^{ac}	1204.23±8.47^{ab}	1262.98±16.95^{a}	0.01
0-42 day	1726.2±22.16^{b}	1866.35±29.97^{a}	1786.67±15.5^{ab}	1832.69±25.3^{a}	0.02
CP intake (g/bird)					
0-21day	45.91±0.44	50.32±1.75	47.65±0.62	46.61±0.98	0.08
22-42 day	95.36±2.1^{b}	102.41±0.73^{a}	98.56±0.69^{ab}	103.37±1.38^{a}	0.01
0-42 day	141.27±1.81^{b}	152.73±2.45^{a}	146.21±1.26^{ab}	149.98±2.06^{a}	0.01
BW gain (g/bird)					
0-21day	92.24±0.59^{c}	94.8±0.79^{b}	98.25±0.57^{a}	84.9±0.98^{d}	0.000
22-42 day	88.56±1.2^{d}	97.68±1.4^{b}	110.16±1.7^{a}	89.4±1.5^{c}	0.000
0-42 day	180.8±1.2^{c}	192.5±1.6^{b}	208.41±1.7^{a}	174.29±1.5^{d}	0.000
EER*					
0-21day	6.08±0.05^{bcd}	6.48±0.22^{ac}	5.92±0.07^{d}	6.71±0.14^{a}	0.02
22-42 day	13.16±0.29^{b}	12.81±0.09^{b}	10.93±0.07^{c}	14.13±0.18^{a}	0.000
0-42 day	9.54±0.12^{b}	9.69±0.15^{b}	8.57±0.08^{c}	10.51±0.15^{a}	0.01
PER**					
0-21day	0.5±0.006^{abc}	0.53±0.01^{ab}	0.48±0.005^{c}	0.55±0.01^{a}	0.000
22-42 day	1.07±0.02^{b}	1.05±0.007^{b}	0.89±0.0^{c}	1.15±0.01^{a}	0.000
0-42 day	0.78±0.01^{b}	0.79±0.01^{b}	0.7±0.01^{c}	0.86±0.0^{a}	0.000

Figures in the same raw with different superscript differ significantly ($p < 0.05$).
Values are reported as means ± SE
* EER= Energy efficiency ratio = Energy intake (kcal)/weight gain (g),
** PER = Protein efficiency ratio= protein intake (g)/weight gain (g)

Table 5: The effects of dietary treatments on carcass characteristics and absolute organ weight (g) of growing Japanese quails

Items	Control	Low MOS	Medium MOS	High MOS	P
Live weight	193.00±2.41^{c}	204.2±4.43^{b}	214.00±2.6^{a}	188.8±5.97^{d}	0.000
Carcass weight	131.6±2.62^{d}	145.2±4.86^{b}	159.6±3.03^{a}	132.2±2.22^{c}	0.000
Dressing %	68.18±0.84^{c}	71.1±1.88^{ab}	74.56±0.59^{a}	70.57±1.04^{b}	0.02
Offals weight	61.4±1.7	59.00±4.2	54.4±0.87	55.6±2.37	0.25
Offals, %	31.82±0.9^{a}	28.88±1.89^{ab}	25.99±0.59^{b}	29.93±1.04^{a}	0.01
Edible giblet wt	14.18±0.6	13.6±0.82	14.6±0.23	13.00±0.75	0.36
Edible giblet %	7.34±0.26	6.68±0.24	6.83±0.18	6.88±0.34	0.45
Liver	5.7±0.27^{b}	5.28±0.42^{b}	6.78±0.13^{a}	5.68±0.42^{b}	0.04
Gizzard	3.46±0.18^{a}	3.32±0.31^{ab}	3.98±0.26^{a}	2.6±0.2^{b}	0.01
Heart	2.33±0.09	2.36±0.16	2.34±0.1	2.28±0.08	0.96
Spleen	0.13±0.02	0.13±0.01	0.15±0.03	0.09±0.01	0.44
Head	12.48±0.5	12.5±1.59	12.22±0.6	11.00±0.07	0.65
Abdominal fat	3.4±0.6^{a}	2.7±0.33^{ab}	1.5±0.16^{b}	2.5±0.35^{ab}	0.03
Legs	5.62±0.96^{a}	4.38±0.28^{b}	5.56±0.06^{b}	3.9±0.32^{b}	0.01

Figures in the same raw with different superscript differ significantly ($p < 0.05$).
Values are reported as means ± SE. n=5 n=number of birds
Offals weight= weight of (blood +feather +head+legs)
Edible Giblet weight = weight of (liver+ skinned gizzard+heart+abdominal fat)
Dressing %, offals %, giblet % are calculated in relation to live weight

Table 6: Effect of MOS on carcass meat composition of Japanese quail

Items	Control	Low MOS	Medium MOS	High MOS	P
Moisture	72.0±0.57	71.67±1.4	74.00±0.58	72.35±1.2	0.37
Crude protein	20.83±0.44	21.63±0.6	21.96±0.08	21.66±0.33	0.11
Fat	3.67±0.35^{a}	2.60±0.31^{b}	1.97±0.09^{b}	2.17±0.27^{b}	0.01
Ash	1.40±0.05^{b}	1.67±0.09^{a}	1.3±0.06^{b}	1.5±0.05^{a}	0.01

Figures in the same raw with different superscript differ significantly ($p < 0.05$).
Values are reported as means ± SE.
n=3 n=number of birds

Table 7: Effects of dietary treatments on some serum parameters of growing Japanese quails

Items	Control	Low MOS	Medium MOS	High MOS	P
Total protein, g/dl	3.18 ± 0.06^{b}	4.30 ± 0.22^{a}	4.16 ± 0.12^{b}	4.08 ± 0.1^{b}	0.000
Albumen, g/dl	1.54 ± 0.09	1.96 ± 0.10	1.70 ± 0.14	1.64 ± 0.14	0.11
Glucose mg/dl	319.8 ± 3.39^{b}	366 ± 5.78^{a}	348.00 ± 1.92^{a}	340.2 ± 6.93^{b}	0.000
T. Choles., mg/dl	191.4 ± 3.4^{a}	172.0 ± 4.06^{b}	164.8 ± 5.00^{b}	177.6 ± 4.7^{b}	0.004
T. lipids, mg/dl	655.0 ± 10.2^{a}	554.0 ± 10.4^{b}	587.00 ± 5.38^{b}	580.27 ± 7.74^{c}	0.000
Triglyceride, mg /dl	110.4 ± 1.6^{a}	85.2 ± 2.85^{c}	81.00 ± 3.7^{c}	94.8 ± 3.38^{b}	0.000

Figures in the same raw with different superscript differ significantly ($p< 0.05$).
Values are reported as means ± SE. n=5 n= number of birds

DISCUSSION

Animals reared under commercial field conditions are subjected to stress, depending on the pathogen load in their environment. Stress is generally accompanied by suppression of body weight and feed intake, which could be the cause of the decline in production. Probiotics, prebiotics and organic acids have been used in the early period of the bird life to prevent the detrimental effects of stress. The addition of specific mannan oligosaccharide (MOS), derived from the outer cell wall of *Saccharomyces cerevisiae*, to a broiler chicken diet has been reported to improve their growth performance (Hooge, 2004; Rosen, 2007, Yang *et al.*, 2008). Also these observations had been depicted in Japanese quails in previous studies (Stanely *et al.*, 2000; Ghosh *et al.*, 2007; Cakir *et al.*, 2008; Sahin *et al.*, 2008). This improvement in growth performance was achieved by saving energy and protein for body growth, which otherwise would be used to combat the growth of pathogenic bacteria (Samarasinghe *et al.*, 2003). By binding pathogenic bacteria possessing type 1 fimbriae, MOS can prevent them from attaching to the gut lining, and this improving its integrity (Loddi *et al.*, 2002). Gut microflora increase energy costs by modifying the rate of energy-consuming reactions such as protein turnover within the chicken GIT (Choct, 1999). The improvement in quails performance by MOS supplementation in this trail was supported by a lot of researches which explain the effect of prebiotics in enhancing resistance to enteric diseases, promoting growth. The authors of these researches ascribed this effect to: (1) inhibits colonization of enteric pathogens by blocking bacterial adhesion to gut lining (Spring *et al.*, 2000; Valancony *et al.*, 2001), (2) enhances immunity (Ferket, 2002; Humphrey *et al.*, 2002), (3), brush border mucin barrier (Iji *et al.*, 2001; Loddi *et al.*, 2002), (4) and integrity of the gut lining (Ferket, 2002) and (5) and reduces enterocyte turnover rate (Spring *et al.*, 2000). These properties have the potential to enhance growth rate, feed conversion efficiency and livability in commercial broilers and turkeys and to increase egg production (Hooge, 2004).

The adverse effect of high MOS level on quail's performance was also observed by Biggs *et al.* (2007) who reported that high dosage of prebiotics can have negative effects on the gut system and retard the growth rate of birds. In an experiment with rat Ten Bruggencate *et al.* (2003) reported that rapid fermentation of prebiotics (fructo-oligosaccharides) leading to high concentrations of organic acids, impaired the barrier function, which reduced the ability of rats to resist salmonella infection in high dietary supplementation. The low MOS level induced slight improvement in growth performance, carcass characteristics, energy and protein efficiency in relation to the control group.

The improvements of carcass weights, dressing percentages, offal's weights and the decrease in abdominal fat in medium MOS supplemented quails were in harmony with the results of previous studies on Japanese quails (Falaki *et al.*, 2011) and broilers (Bozkurt *et al.*, 2008; Zhou *et al.*, 2009). It was hypothesized that a decrease in intestinal pathogen challenge provided by MOS would result in improvement in nutrient utilization and allocation leading to benefits in lean muscle gain (Ferket, 2004). The improvements of carcass characteristics confirm the results of body weight and body gain in medium MOS supplemented birds. Spring *et al.* (2000) ascribed this result could be due to decreased proliferation of pathogenic bacteria. The decrease in abdominal fat was consistent with results of Ammerman *et al.* (1989) who concluded that the addition of 0.3% oligofructose to the bird's ration decreased the percent of abdominal fat.

Recently, an increasing number of consumers have been demanding that food products be safe and healthy. Therefore, low-fat chickens are currently very popular products in international markets. Interestingly, in this study, the triglycerides, total cholesterol and total lipids concentration in blood decreased in concomitant with a significant decrease in carcass fat % as a response to MOS treatments. Triglycerides are secreted from the liver into the blood by triglyceride- rich lipoproteins; therefore, impaired hepatic lipogenesis results in decreased triglyceride concentrations in plasma. These results agreed with the results of earlier studies in which prebiotics found to lower the concentration of blood lipids in quails (Sharifi *et al.*, 2011), broilers (Li *et al.*, 2007; Ashayerizadeh *et al.*, 2009; Rabie *et al.*, 2010) and in piglets (Tang *et al.*, 2005).

The reduction in serum total cholesterol of quails fed probiotic and prebiotic supplemented diets could be attributed to the reduced absorption and or synthesis of cholesterol in the gastro-intestinal tract (Mohan *et al.*, 1996; Ghiyasi *et al.*, 2008). The most important mechanism by which prebiotic eliminates cholesterol would likely be through reducing lipid absorption in intestine by binding bile acids, which results in increased cholesterol elimination and hepatic synthesis of new bile acids (Zhang *et al.*, 2003; Taherpour *et al.*, 2009).

The response of some physiological variables was non linear and tended to peak at medium and low concentrations of MOS. Based on the results of the current study, it can be concluded that, responses of Japanese quails to MOS supplementation are influenced by the level of supplementation. Therefore, this factor need to be carefully considered in order to obtain maximal growth-promoting effects of MOS in Japanese quails production.

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اثر إضافة **Mannan oligosaccharides (MOS)** علي أداء ومواصفات الذبيحة في السمان الياباني النامي

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اجريت هذه التجربة لتقييم أثر إضافة ثلاث مستويات غذائية من MOS علي بعض الصفات الإنتاجية ومواصفات الذبيحة وبعض مكونات الدم في السمان الياباني النامي. لذلك تم استخدم عدد ١٠٠ طائر من السمان الياباني النامي عمر يوم تم تقسيمهما عشوائيا إلي عدد ٤ مجموعات بكل منها عدد ٢٥ طائر وقسمت كل مجموعة إلي ٣ مكررات (اثنان بهما ٨ طيور وواحدة بها ٩ طيور). غذيت المجموعة الأولي علي العليقة الضابطة بدون أي إضافات، في حين غذيت المجموعة الثانية والثالثة علي العليقه المقارنة بعد اضافة ١ جم MOS /كجم عليقه (مستوي منخفض)، و ٣ جم MOS/كجم عليقه (مستوي متوسط) لكل منهما علي التوالي. اما المجموعة الرابعة فقد أضيف الي عليقتها ٥جم MOS /كجم عليقه (مستوي مرتفع). وذلك في تجربة استمرت ستة اسابيع. أظهرت النتائج أن إضافة المستوي المتوسط (٣ جم MOS /كجم عليقة) أعطي افضل أداء إنتاجي تمثل في تحسن معنوي في في كل من الزيادة في وزن الجسم ومعدل الكفاءة التحويلية للغذاء ومؤشر الأداء وكذلك نسبة التصافي والأجزاء المأكولة من الطائر مقارنة بالمستويات الأخرى وكذلك التي تمت تغذيتها علي العليقة الضابطة فقط. كما لوحظ أيضا أن إضافة المستوي المتوسط من MOS أدي إلي تحسن كفاءة تحويل الطاقة والبروتين. اوضحت النتائج ان المستوي المنخفض من MOS ادي إلي تحسن طفيف في الأداء الإنتاجي للطيور في حين كان اثر المستوي المرتفع سلبياً علي الأداء الإنتاجي للطيور. اوضحت النتائج ان إضافة MOS أدت إلي انخفاض الكولسترول والدهون الكلية والجليسريدات الثلاثية في دم السمان الياباني النامي عند جميع المستويات المضافة. وقد خلصت النتائج الي أن الممستوي المتوسط من MOS حقق أفضل النتائج مما يؤكد اهمية مراعاة مستوي إضافة MOS إلي علائق السمان وذلك للحصول علي أعلي إنتاج دون الحاجة إلي استخدام المضادات الحيوية في هذا الصدد.